

EXECUTIVE SUMMARY

DCERP Annual Technical Report I:
November 2006–February 2008
Executive Summary

SERDP Project RC-1413

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DCERP Annual Technical Report I: November 2006–February 2008

Executive Summary

Overview

The Defense Coastal/Estuarine Research Program (DCERP) is a research-based program that is sited at Marine Corps Base Camp Lejeune (MCBCL), NC. This program provides a unique opportunity to integrate the results of broadly scoped ecological research to understand the structure and function of diverse coastal ecosystems, while directly integrating this research to address the Base's management needs for sustaining the military training mission. Phase I of the DCERP was successfully completed in June 2007 and resulted in the development of a *DCERP Strategic Plan*, a *Baseline Monitoring Plan*, and a *Research Plan*, which will serve as the foundation for the future DCERP activities at MCBCL.

Implementation of these plans (Phase II) was initiated in July 2007 and has resulted in the establishment of more than 200 monitoring stations and 13 research projects. In addition, the Data Information and Management System (DIMS) was designed to archive DCERP monitoring and research data and to allow for the exchange of information among the various DCERP partners. Research and monitoring activities during Phase II of DCERP are currently planned for 4 years (until November 2011). The overall vision of DCERP is to help ensure that MCBCL sustains military training and testing activities using adaptive management based on a relevant and applied monitoring and research program.

1. Background

Critical military training and testing on lands along the nation's coastal and estuarine shorelines are increasingly placed at risk because of development pressures in surrounding areas, impairments due to other anthropogenic and climatic disturbances, and increasing requirements for compliance with environmental regulations. The U.S. Department of Defense (DoD) intends to enhance and sustain its training and testing assets and optimize its stewardship of natural resources through the development and application of an ecosystem-based management approach on DoD facilities. To expand its commitment to improving military readiness while using the science to support this approach, the Strategic Environmental Research and Development Program (SERDP) has made a commitment of at least 10 years to fund research and monitoring projects that support the sustainability of military training in these ecologically and economically important ecosystems.

To accomplish this goal, SERDP launched DCERP at MCBCL in North Carolina. MCBCL provides an ideal platform for DCERP because it integrates coastal barrier, aquatic/estuarine, coastal wetlands, and terrestrial ecosystems, all within the boundaries of DoD properties. DCERP is a collaborative effort among SERDP, the Naval Facilities Engineering Service Center, MCBCL, and the RTI International¹ (RTI) DCERP Team. This team consists of a partnership among scientists from RTI, seven academic universities, two government agencies, and two private companies. Headquartered in Research Triangle Park, NC, RTI is leading the DCERP research and monitoring effort.

Overall Benefits to MCBCL from DCERP

- Establish a water quality monitoring network of stations in the New River, the New River Estuary, and major tributary creeks to ensure the preservation of training waters and Clean Water Act compliance
- Determine which shorelines are vulnerable to erosion and provide information on sediment dynamics to better prepare for future sea-level rise
- Understand the hydrodynamics, biology, and sediment transport mechanisms to preserve Onslow Beach for training, while complying with the Endangered Species Act
- Conduct research on forest management techniques to provide more available training land, while meeting red-cockaded woodpecker recovery plan goals
- Provide information on atmospheric pollutants for Clean Air Act compliance and data on regional nutrient cycling that mediates both terrestrial and aquatic ecosystems.

¹ RTI International is a trade name of Research Triangle Institute.

DCERP was implemented in two phases. Phase I was successfully completed and resulted in the development of three key deliverables: the overarching research strategy (*DCERP Strategic Plan*), the design of an ecosystem-based monitoring program (*DCERP Baseline Monitoring Plan*), and the identification of detailed research projects (*DCERP Research Plan*). Phase I also featured the development of the DIMS. Phase II of DCERP, the program's implementation period, includes the execution of the *DCERP Research Plan* through field research, the operation of the long-term baseline monitoring system, and the management and analysis of data from both the research and monitoring components in the DCERP DIMS. This Executive Summary highlights the accomplishments from Phase I and the first 9 months of Phase II (inclusive of November 2006–February 2008).

RTI DCERP Team

RTI has assembled the following diverse team of experts, collectively referred to as the RTI DCERP Team:

Atmospheric Research and Analysis
Duke University
National Oceanic and Atmospheric Administration
North Carolina State University
Porter Scientific
RTI International
U.S. Geological Survey
University of North Carolina at Chapel Hill
University of North Carolina at Wilmington
University of South Carolina
Virginia Institute of Marine Sciences
Virginia Polytechnic Institute and State University

2. Integration with MCBCL's Natural Resources Management

MCBCL's mission is to provide military training that promotes the combat readiness of operating forces, and all MCBCL natural resources management activities on the Base must support this mission. As a military installation, MCBCL has needs, or drivers (**Table ES-1**), that must be satisfied to meet its readiness mission to continue training without significant disruption. MCBCL must also comply with relevant environmental laws and regulations, such as the federal Endangered Species Act (ESA) and the Clean Water Act (CWA), to ensure continuance of its mission. To ensure such compliance, MCBCL developed and adopted an Integrated Natural Resources Management Plan (INRMP). One goal of the INRMP is to minimize future training restrictions (i.e., no net loss in the ability to train) by increasing the integration between MCBCL natural resources management planning, training, and operations. One of DCERP's objectives is to assist MCBCL in achieving this goal. As such, Base staff members were involved throughout the DCERP planning phase by participating in all planning workshops and reviewing the *DCERP Strategic Plan*, *Baseline Monitoring Plan*, and *Research Plan*.

Table ES-1. Unique to MCBCL Are Installation-Specific Military Drivers That Are Defined by the Base's Mission and Geographic Location, Land Uses to Support the Mission, and Natural Resources Affected by the mission

Driver 1	Preserving the integrity of the amphibious maneuver areas, including Onslow Bay, the New River Estuary (NRE), and the adjoining training areas and airspace of the Marine Corps Base Camp Lejeune (MCBCL)
Driver 2	Preserving the integrity of MCBCL as a combined-arms training Base by ensuring the continued viability of its impact areas and associated training ranges
Driver 3	Enhancing future training uses of MCBCL ranges, training areas, and airspace by fully integrating the Land Use Master Plan and Range Transformation Plan
Driver 4	Ensuring that MCBCL supports all required military training activities, while complying with the Endangered Species Act and other wildlife requirements
Driver 5	Ensuring that MCBCL supports continued military training use of the New River, the NRE, and Onslow Bay while complying with the Clean Water Act
Driver 6	Ensuring the viability of the U.S. Marine Corps New River Air Station as an aviation facility through the elimination of bird and wildlife strike hazards to aircraft while complying with the ESA and other wildlife regulatory requirements

3. Summary of the DCERP Baseline Monitoring and Research Activities

To facilitate an understanding of the ecosystem state and dynamics of MCBCL, the following five ecosystem modules were established for monitoring, modeling, and research: the Aquatic/Estuarine Module, the Coastal Wetlands Module, the Coastal Barrier Module, the Terrestrial Module, and the Atmospheric Module. As part of the strategic planning process, conceptual models were developed to illustrate the key physical, biological, and chemical processes and stressors for each of the five ecosystem modules. After developing the individual conceptual models, the RTI DCERP Team identified knowledge gaps in the models, worked with the Base staff to identify the needs of MCBCL management, and then determined potential research questions to fill these basic knowledge gaps and to address MCBCL management needs. The DCERP baseline monitoring program was designed to gather environmental data and support research projects aimed at addressing MCBCL's management concerns. An overall map of the Base that identifies the module-specific monitoring and research locations is provided in **Figure ES-1**.

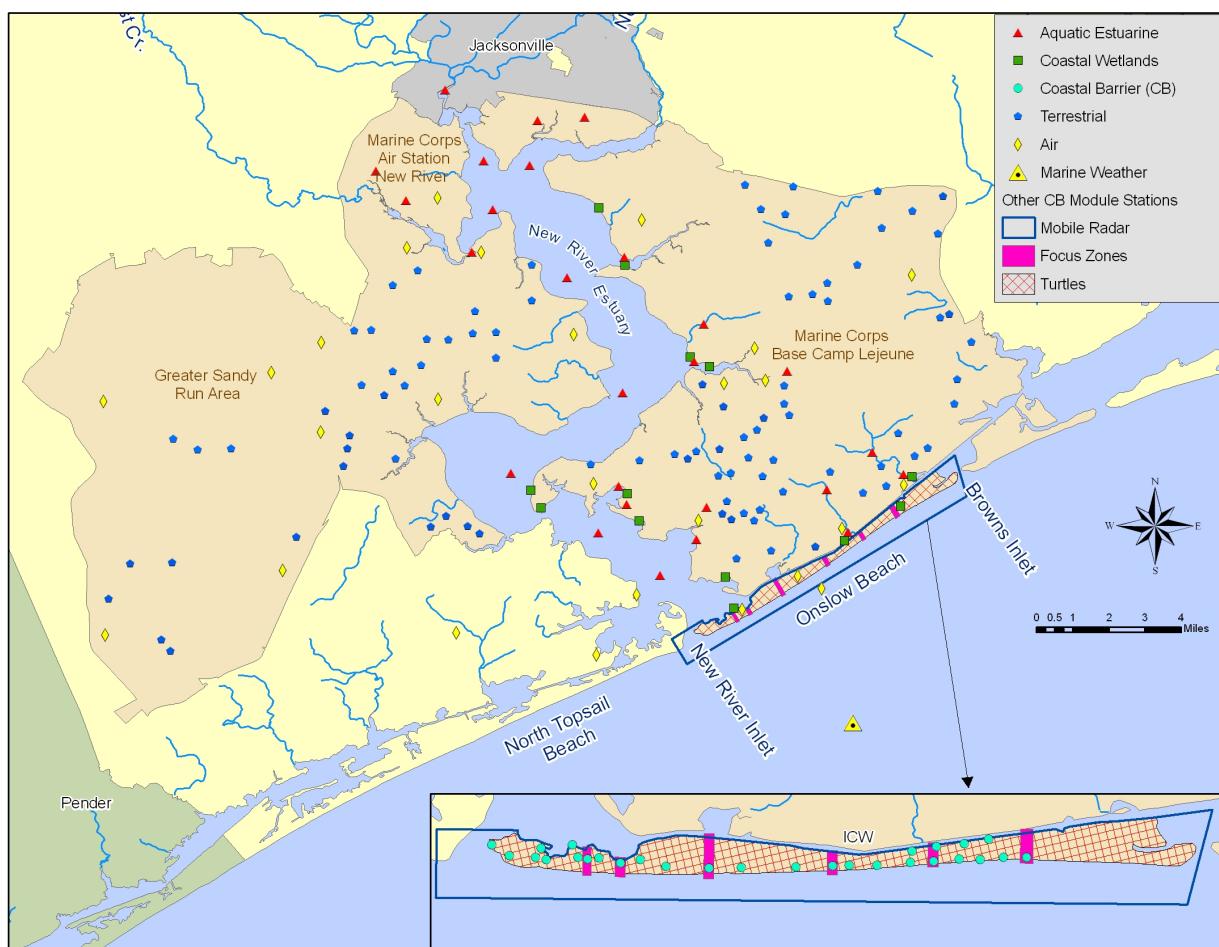


Figure ES-1. Module-specific monitoring and research locations.

3.1 Baseline Monitoring Program

For the purposes of DCERP, baseline monitoring includes monitoring of basic (fundamental) parameters that support the broader research agenda and providing data that are useful to more than one ecosystem module. Data must be monitored for a minimum of 5 years and will be transitioned in a scaled-down form to MCBCL for monitoring at the end of the DCERP effort. The DCERP monitoring program is described in the *DCERP Baseline Monitoring Plan* and includes the activities listed in **Table ES-2**.

Table ES-2. Summary of Module-Specific DCERP Baseline Monitoring Program Activities

Modules	Activities
Aquatic/ Estuarine ^a	<u>Hydrodynamics</u> : Stream flow and discharge (New River and creeks) <u>Chemistry</u> : Nutrients, salinity, pH, oxygen, temperature (New River, New River Estuary [NRE], creeks) <u>Sedimentology</u> : Total suspended solids (New River, creeks), turbidity (NRE) <u>Biology</u> : Primary productivity, phytoplankton, fluorescence (NRE)
Coastal Wetlands	<u>Land cover and shoreline erosion</u> : Location, elevation <u>Hydrodynamics</u> : Tide gauges (hydroperiod) <u>Chemistry</u> : Nutrients, salinity, hydraulic conductivity (shallow groundwater) <u>Sedimentology</u> : Accretion rates, organic content, particle size
Coastal Barrier	<u>Hydrodynamics</u> : Wave velocity, wave heights/period, currents, shoreline position, morphology <u>Meteorology (ocean)</u> : Air temperature, wind velocity, barometric pressure, humidity, solar radiation <u>Sedimentology</u> : Texture, compaction, composition, sediment volume <u>Biology</u> : Benthic invertebrates, fish, shorebirds/seabirds, dune/shrub/marsh vegetation, sea turtles
Terrestrial	<u>Land cover/land use</u> : Determine changes in land cover/land use (vegetation types, buildings, roads) <u>Biology</u> : Vegetative community assessment, fuel load <u>Soil</u> : Soil bulk density, pH, organic matter content
Atmospheric	<u>Meteorology (air)</u> : Wind speed, wind direction, relative humidity, temperature, photosynthetically active radiation, precipitation <u>U.S. Environmental Protection Agency criteria pollutants</u> : Ozone and fine and coarse particulate matter (mass)

^a Sedimentology, chemistry, and biology of the NRE benthic zone are characterized in Research Project AE-3.

3.2 Research Program

During Phase I, the RTI DCERP Team also designed the research program to increase the knowledge base and understanding of MCBCL-relevant ecosystem functioning, stressors, and system responses to stressors and management actions. The overall research program that is presented in the *DCERP Research Plan* consists of 13 separate research projects as shown in **Table ES-3**.

Table ES-3. Summary of 13 DCERP Research Projects

Research Project Title	Senior Researcher; Project Duration
AE-1: Develop and Deploy Microalgal Indicators as Measures of Water Quality, Harmful Algal Bloom Dynamics, and Ecosystem Condition	Hans Paerl; 7/2007–6/2011
AE-2: Quantifying and Predicting Watershed Inputs of Nutrients, Sediments, and Pathogens	Mike Piehler; 7/2007–6/2011
AE-3: Developing Indicators of Ecosystem Function for Shallow Estuaries: Benthic Functional Responses in the New River Estuary (NRE)	Iris Anderson; 7/2007–6/2011
CW-1: Determine Responses of Marsh Vegetation and Accretion to Relative Surface Elevation	Jim Morris; 7/2007–6/2011
CW-2: Forecast Influence of Natural and Anthropogenic Factors on Estuarine Shoreline Erosion Rates	Mark Fonseca; 9/2007–6/2011

Research Project Title	Senior Researcher; Project Duration
CW-3: Hydraulic Exchange and Nutrient Reactivity in the NRE Wetlands	Craig Tobias; 7/2008–6/2011
CB-1: Short-Term Barrier Evolution Related to Storms and Land Use	Jesse McNinch; 7/2009–6/2011
CB-2: Long-Term Barrier Evolution Related to Variations in Underlying Geology, Land Use, and Inlet Dynamics	Tony Rodriguez; 7/2009–6/2011
CB-3: Understanding the Top-Down and Bottom-Up Drivers of Shorebird Nest Success and Habitat Use in Relation to Beach Management Practices on Marine Corps Base Camp Lejeune	Sarah Karpanty and Jim Fraser; 7/2007–6/2009
T-1: Effects of Different Midstory Restoration Management Options on Terrestrial Ecosystem Structure and Function	Norm Christensen; 1/2008–6/2011
T-2: Effects of Habitat Management for Red-Cockaded Woodpeckers on Bird Communities	Jeff Walters; 1/2008–6/2011
Air-1: Optimization of Prescribed Burning by Minimizing Smoke Emissions and Maximizing Vitality of Fire-Adapted Ecosystems	Karsten Baumann; 7/2008–6/2011
Air-2: Nitrogen Deposition to Terrestrial and Aquatic Ecosystems	Wayne Robarge; 7/2007–6/2011

Note: AE = Aquatic/Estuarine Module; Air = Atmospheric Module; CB = Coastal Barrier Module; CW = Coastal Wetlands Module; T = Terrestrial Module

4. Aquatic/Estuarine Module Summary

Aquatic/Estuarine Module monitoring and research programs have been in place since October 2007 and are fulfilling the module's objectives. These objectives include improving our understanding of the complex physical, chemical, and biotic processes that drive water and habitat quality; differentiating natural and anthropogenic ecosystem stressors (current and future) at local and regional scales, considering extreme climatic events, such as hurricanes and droughts; and integrating results with the other DCERP modules. The benefits of the Aquatic/Estuarine Module monitoring and research program include providing information needed to preserve the integrity of the amphibious maneuver areas, including the New River Estuary (NRE) (Military Driver #1), and ensuring continued military training activities while complying with the CWA (Military Driver #5).



The Aquatic/Estuarine Module Team has developed its monitoring and research program to provide information on land use impacts, including military training, on water quality in the New River Estuary.

Major accomplishments and benefits to the Base this year include the following:

- A U.S. Geological Survey (USGS) stream-gauging station was installed in the New River, upstream of its entrance into the NRE near the City of Jacksonville, NC. This new stream-gauging station provides real-time data on stream flow, water level, discharge, salinity, dissolved oxygen, pH, and water temperature. In addition, nutrient and sediment data are being monitored

at this station. These data provide insights on water quality conditions originating from the upstream boundary of the New River to the head of the estuary.

- Tributary creek monitoring was initiated at 5 pairs of stations (10 sites) in August 2007. One of each pair is a station that has been affected by various MCBCL land uses, and the other is a control or reference station.
- Intensive measurements of nutrients, bacteria, and suspended materials were collected at four sites in tributary creeks to the NRE. These data will allow a rigorous calculation of the magnitudes and patterns of loadings of these materials from creeks throughout the estuarine gradient receiving varied MCBCL land uses.
- Preliminary results from the eight estuarine water quality monitoring stations demonstrate strong seasonal and spatial patterns in phytoplankton community biomass and composition in the NRE. These results can be used to detect and characterize internal and external perturbations, including freshwater and nutrient pulses, sedimentation events, and droughts, as well as to detect and quantify algal bloom events.
- Three intensive seasonal studies of benthic and pelagic habitat quality at six shallow-water stations in the estuary and Intracoastal Waterway (ICW) were completed. Preliminary results show expected gradients in salinity, light penetration, chlorophyll *a*, and nutrients. Shallow-water sediment chlorophyll *a* concentrations were surprisingly high, suggesting a critical role of benthic algae in nutrient cycling in the NRE.



The water column of the NRE is monitored at eight stations throughout the axis of the estuary.

Aquatic/Estuarine Module activities planned for next year include the following:

- Continue monitoring at the 2 USGS stream-gauging stations, 10 tributary creek stations, and 8 estuarine stations to characterize water quality conditions and assess the impact of MCBCL land use on estuarine water quality
- Examine nutrient limitation/enrichment on microalgal growth and test diagnostic photopigments and molecular (for harmful algal blooms) analyses
- Assess human versus climatic impacts on water quality and habitats with an emphasis on impacts from on-site and off-site development, military training activities, and storms and droughts to determine the ecological condition and sustainability of the NRE
- Perform surface mapping of water quality parameters across shallow-estuarine and tributary waters to understand the influence of watershed inputs from tributary creeks and shoreline impacts on shallow-water habitat quality
- Conduct in situ experiments at NRE benthic stations to determine how benthic and pelagic metabolism and nutrient cycling vary as functions of nutrient enrichment and light quality and quantity
- Develop and begin calibration of the Estuarine Simulation Model to predict biogeochemical cycling and food web dynamics in the NRE.

5. Coastal Wetlands Module Summary

The health of the coastal wetlands dictates their ability to serve as a trap for nutrients and sediments, which improves water quality in the NRE. In addition, marshes protect Base infrastructure by serving as a buffer against coastal storms, as well as compensating for rising sea level. Salt marshes also support the coastal barrier island and are essential to its continued survival. The overall monitoring and research

program of the Coastal Wetlands Module is designed to provide quantitative information about the condition and dynamics of coastal marshes at MCBCL and to forecast future changes in the condition of these coastal marshes due to anticipated increases in training activities and sea-level rise. These programs were designed to address two of the MCBCL military drivers, preserve the integrity of the amphibious maneuver areas in the NRE (Military Driver #1), and ensure that MCBCL supports continued military training activities while complying with the CWA (Military Driver #5).

Major accomplishments and benefits to the Base this year include the following:

- Two marsh planters were installed at Freeman Creek to provide information on the growth of marsh vegetation (*Spartina alterniflora*) as a function of relative marsh elevation.
- Ten Surface Elevation Tables (SETs) were installed at three stations in the lower NRE and ICW to monitor changes in marsh surface elevation and sediment erosion/accretion processes.
- A water-level sensor was installed at Mile Hammock Bay to provide tidal height data (no other tidal data are available within 30 miles of the NRE). A combination of accurate tide data and bathymetry of the New River Inlet will help MCBCL with egress/ingress of landing craft units at Mile Hammock Bay.
- The Wave Exposure Model (WEMo) was run using 3 years of wind data for the NRE, and WEMo calibration exercises were conducted. WEMo camera installation sites were selected for capturing boat activity in the NRE and ICW.
- A network of shallow groundwater monitoring equipment was installed in the marsh at French Creek to determine water and nutrient exchange between the upland groundwater and the NRE. Freeman and Traps creeks were also evaluated for equipment installation.



Marsh planters were established at Freeman Creek and were fertilized with nutrients for Research Project CW-1.

Coastal Wetlands Module activities planned for next year include the following:

- Use of aerial imagery (1938 to date) to evaluate wetland distribution, species composition, and shoreline erosion patterns in the NRE and ICW; complete wetlands vegetation mapping at 11 sites
- Complete WEMo calibration using sensor data from three sites in the NRE and ICW, run scenarios of wind events for the NRE, and classify NRE shoreline by wind wave energy; identify shoreline erosion hotspots on MCBCL lands and explore the contribution of wind wave and boat wake energy to erosion rates
- Determine the location of shoreline sites along the gradient of wave energy exposure based on results from WEMo and install additional SETs and benchmarks in the middle or upper NRE
- Analyze tidal data in collaboration with the National Oceanic and Atmospheric Administration's Center for Operational Oceanographic Products and Services
- Construct a Digital Elevation Model (at 11 sites) in the NRE and ICW that will establish a baseline condition against which future marsh elevation change can be measured

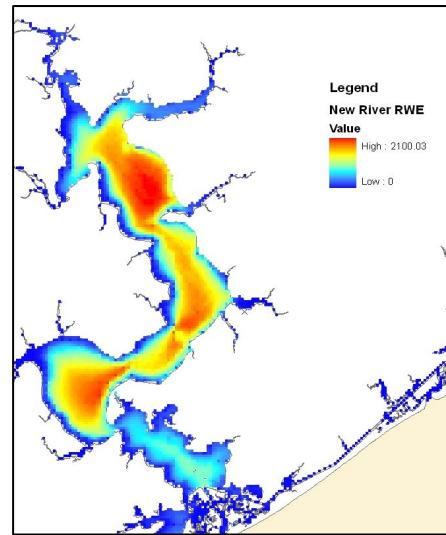
- Parameterize a model of sediment accretion (Marsh Equilibrium Model 2) that will provide an opportunity to observe the consequences of a potential management tool that may be used to mitigate effects of sea-level rise or marsh erosion resulting from landing craft air cushion (LCAC) activity
- Measure nutrient flux and composition and freshwater flux through shallow marsh groundwater monitoring instruments deployed at French, Traps, and Freeman creeks
- Evaluate marsh response to hurricanes and other storm events, including elevation, sedimentation, vegetation, shoreline erosion, and tidal height.

6. Coastal Barrier Module Summary

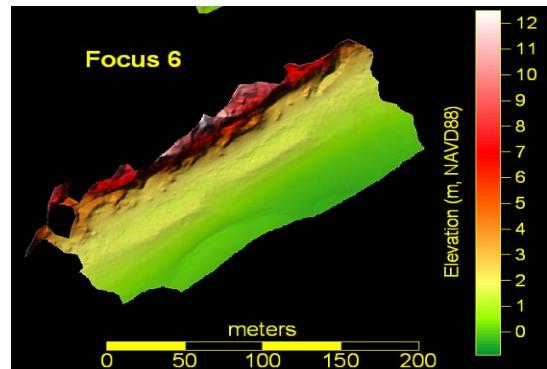
The coastal barrier island has been identified by MCBCL staff as a critical part of the Base's amphibious assault training program, and thus warrants management strategies that will enable continued training use of the beach while facilitating it as a sustainable ecosystem. To preserve the land mass in a form that sustains Base activities into the future, it is necessary to understand the causes of and responses to erosion-rate variability. During amphibious training exercises, the coastal barrier ecosystem receives significant boat, foot, and vehicular traffic; however, the underlying geology and natural sediment-transport pathways may overwhelm any contribution to erosion from anthropogenic stressors. Understanding this relationship will be fully examined in the coastal barrier monitoring and research programs and will help improve management of the coastal barrier to preserve the integrity of the amphibious maneuver areas, including Onslow Bay (Military Driver #1), and of MCBCL as a combined-arms training Base by ensuring continued viability of its associated training ranges (Military Driver #2). In addition, the Coastal Barrier Module's research and monitoring program will help the Base comply with the ESA (Military Driver #4) by understanding the habitat quality needed to sustain sea turtle and shore bird use of the island. Sediment compaction, texture, and composition are important factors in sediment transport, benthic invertebrate composition and abundance, bird-foraging success, and thus habitat quality.

Major accomplishments and benefits to the Base this year include the following:

- Detailed topographic and bathymetric data were collected on the coastal barrier island (Onslow Beach) and in the near-shore waters, respectively.
- Detailed digital maps of coastal barrier morphology were produced in a format that can easily be viewed by MCBCL staff with any geographic information systems software.
- Hydrologic buoy data were analyzed to determine the seasonal variability of the wave field of Onslow Bay.
- Preliminary research results show the greatest quantity of sand in the near shore is found at the northern end of Onslow Beach. This part of the



Preliminary WEMo result illustrates shoreline areas prone to erosion (shown in red) that will be monitored in more detail.



Detailed morphology of the beach at the northeastern end of Onslow Beach illustrates a narrow shoreline and the extensive dune system.

coastal barrier island also has the highest and most extensive dunes and the widest backshore area.

- Monitoring results obtained before February 2008 can serve as a benchmark of beach condition before the U.S. Army Corps of Engineers' dredging of the ICW and dumping of dredge spoils on north Onslow Beach. This information can be used by the Base, in conjunction with future data, to quantify the impacts and quality of the dredge material deposited on Onslow Beach.
- Information in six focus zones along Onslow Beach was collected to assess benthic invertebrate populations, ghost crab populations, and surf fish populations.



The Coastal Barrier Module divided the beach into six areas where information was collected on benthic invertebrate populations (middle/low intertidal and subtidal), ghost crab populations (dune, backshore, and high intertidal), and surf fish populations (subtidal).

- MCBCL paper records of sea turtle and shorebird data were acquired, validated, and digitized into a searchable electronic database, increasing the available digitized data from 4 to 21 years. This new database will provide the Base staff with easy access to information needed to meet the requirements of the ESA.
- Camera traps were installed and used to identify a diverse community of both natural and feral predators on Onslow Beach, including bobcat, raccoon, opossum, and gray fox, as well as domestic cats and dogs. A more comprehensive understanding of predator dynamics on Onslow Beach will contribute to MCBCL management of shorebirds and sea turtles and meeting requirements of the ESA.

Coastal Barrier Module activities planned for next year include the following:

- Map the bathymetry of the surf zone using a mobile radar unit and the topography of 14 beach sites using a three-dimensional laser scanner to determine the morphology and sediment distribution along Onslow Beach
- Analyze surface sediment from seven focus sites, including the area on Onslow Beach where dredge spoils were deposited, for texture and mineralogy to determine habitat quality
- Quantify the seasonal abundances of benthic invertebrates and ghost crabs, as well as before and after a major storm; annually estimate surf fish abundances in the fall
- Digitize and analyze MCBCL's records of off-road recreational vehicle use to uncover temporal patterns of beach visitation and identify potential periods of high vehicle impact to the beach



Avian species distribution and abundance will be determined for specific zones on Onslow Beach.

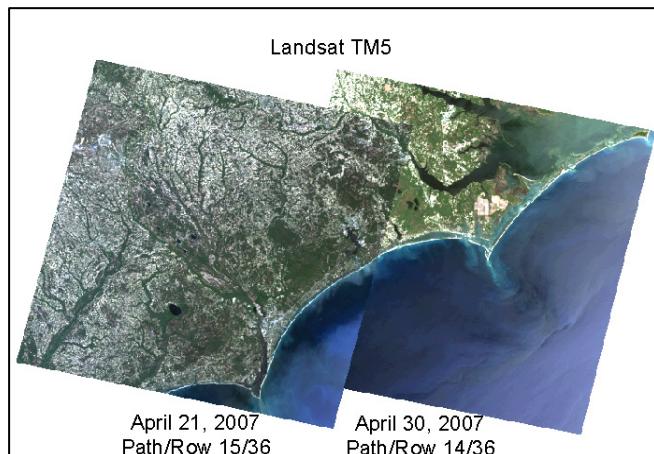
- Observe and quantify the effects of various military vehicles on beach structure during training exercises
- Observe and measure sea turtle hatchling survival during their transit across the beach to assist MCBCL management in protecting these protected species
- Evaluate and reformat MCBCL digitized data associated with sea turtle nesting and shorebird abundance into an electronic database, which will be searchable by species and beach mile, after additional information is obtained from the Base
- Describe population dynamics, including nesting, nest success, and fledging success of shorebirds, as well as foraging and nesting habitat availability across the three use zones on Onslow Beach
- Evaluate the presence and potential effects of local predators on the nesting success and within season survival of focal shorebird species across the three beach use zones on Onslow Beach
- Evaluate the levels and impacts of human use at Onslow Beach on predator abundance, avian distribution and abundance, nest success, productivity, and survival.

7. Terrestrial Module Summary

The monitoring and research program of the Terrestrial Module is designed to provide a greater understanding of the Base's management of terrestrial lands and how the use of prescribed fire and other forest management techniques affect plant and animal communities across MCBCL. One objective of the Terrestrial Module is to provide baseline information to all DCERP Module Teams on the land use/land cover changes that have occurred at MCBCL over the past 20 years and to monitor future changes. The land use/land cover change analyses will identify change at two scales: regionally within the New River watershed and locally across MCBCL lands. Other objectives for this module are to develop and implement protocols for the efficient monitoring of terrestrial ecosystems and to conduct focused studies on existing loblolly pine habitat that are being managed by MCBCL natural resources managers for the red-cockaded woodpecker (RCW). Avian sampling will provide a broader examination of the relationship between RCW foraging habitat quality and the composition of the bird community. The results from these programs can be applied by MCBCL staff to enhance future training uses of MCBCL ranges and training areas (Military Driver #3) and to ensure that MCBCL supports required military training activities while complying with the ESA (Military Driver #4).

Major accomplishments and benefits to the Base this year include the following:

- State, national, and MCBCL imagery and satellite datasets were identified and acquired to conduct land use/land cover change analyses at various spatial scales.
- Specifically, high-quality, cloud-free Landsat Thematic Mapper (TM) imagery was identified and purchased from 1984 and 2007 for the entire New River watershed. This 23-year time period provides an excellent reference for land use/land cover change across MCBCL up to the present time.
- Research Project T-1 was redesigned in full collaboration with the MCBCL staff to study the effects of different understory restoration management



Landsat TM imagery for MCBCL from 2007 that has been georectified. This imagery will be compared with the 1984 imagery for the land use and land cover change analysis.

options on terrestrial ecosystem structure and function. This project will evaluate Base forestry management techniques, as well as the impact of forest management on sensitive at-risk species, such as the RCW. Appropriate adjustments were made to Research Project T-2 so that these two projects will remain closely integrated.

Terrestrial Module activities planned for next year include the following:

- Characterize the current land use and land cover of MCBCL. This activity, which is planned to be completed in summer 2008, will provide baseline conditions against which the future changes can be compared. This analysis product can be used by the Base to support the development of an Environmental Impact Statement necessitated by the future 202k staff increase.
- Process and refine initial hydrologic flow and watershed delineations, develop initial change vector analysis change detection time series, and acquire additional georectify high-resolution imagery
- Select and sample approximately 100 terrestrial vegetation monitoring locations to assess changes in plant species composition, diversity, and distribution
- Coordinate with MCBCL staff to identify stands slated for longleaf pine restoration (focus attention on large areas of loblolly pine with a developed hardwood midstory)
- Assess the effects of combinations of mechanical and herbicide removal of hardwoods on understory vegetation, insects, and avifauna; evaluate the influence of manipulation of the forest floor and the addition of native herb seed to the test plots
- Commence sampling of bird communities on the restoration plots established in Research Project T-1, so that effects of restoration methods on avian communities, as well as RCW foraging habitat quality, can be assessed.



Vegetation research plots focus on areas that were converted from longleaf pine to loblolly pine.

8. Atmospheric Module Summary

The input of nutrients and potential pollutants via atmospheric deposition interacts with most key terrestrial and aquatic ecological processes occurring at MCBCL. The monitoring and research program of the Atmospheric Module will help describe and improve the understanding of critical pollutant transport and advection processes that are subject to complex land-sea-breeze circulation patterns and more regional synoptic forces. This improved understanding will be gained through the joint use of existing and supplementary monitoring activities, allowing for the identification of ecosystem stressors, their sources that are internal and external to the MCBCL, and their respective range of impact to ensure Base compliance with the Clean Air Act. In addition, the Atmospheric Module will provide estimates of direct wet deposition and indirect dry deposition to the NRE within the confines of MCBCL with an estimate of the total atmospheric nutrient loading that will assist the Base in meeting CWA goals (Military Driver #5).

Major accomplishments and benefits to the Base in this year include the following:

- Ambient air quality monitoring equipment was deployed at three sites (i.e., Rouse Pier, Greater Sandy Run Area tower, and the Marine Corps Air Station New River).

- Ozone and meteorological parameters are being measured continuously at these locations on Base, covering the gradient from the beach to the area farthest inland.
- Atmospheric nitrogen deposition equipment and rain gauges were tested for deployment as part of Research Project Air-2.

Atmospheric Module activities planned for next year include the following:

- Acquire and review regional air quality data off Base from the N.C. Department of Environment and Natural Resources's Division of Air Quality stations for comparison to on-Base measurements of criteria pollutants in the context of regional air quality; collect and review meteorological data from existing local sites
- Prepare monthly and seasonal evaluations of MCBCL air quality against the new seasonal ozone and daily fine particulate matter (PM_{2.5}) National Ambient Air Quality Standards
- Evaluate data from wet deposition collectors, portable meteorological stations, tipping bucket rain gauges, and throughfall/stemflow collectors from across the Base to assess the influence of wind patterns, as well as the sea salt aerosols.



An ambient air monitoring station located near Rousey Pier on Onslow Beach.

9. Assessment of Military Training Impacts

In addition to the DCERP research and monitoring activities previously mentioned, SERDP determined that it was important to develop a scientific framework in which to assess the impact of military training on the various ecosystems of MCBCL at various spatial and temporal scales. To achieve this goal, the following four tasks were undertaken to evaluate current understanding of how to assess military training impacts on terrestrial and aquatic systems:

- Conduct a literature search and review of military training impacts on DoD installations in similar ecological settings or that employ similar vehicles and training practices to those of MCBCL
- Collaborate with MCBCL staff and the DCERP Terrestrial Module Team members to determine the nature and extent of observed impacts to training areas of the Base and to determine what training activities or vehicle types result in observable impacts
- Analyze the Range Facility Management Support System (RFMSS) to determine its ability to provide data for assessing the frequency and magnitude of training activities in the various MCBCL ranges and facilities
- Analyze information from the RFMSS, in conjunction with the land use/land cover data, to help integrate the spectrum of military training impacts to the terrestrial and aquatic settings of MCBCL.



Landing zones can be used for a variety of military training activities that can impact the ecosystem.

Information from these four tasks will enable the RTI DCERP Team to identify potential indicators of military impacts for each ecosystem and to make

changes as appropriate to DCERP Baseline Monitoring and Research plans to discriminate military stressors from other stressors. In addition, the results from these activities can provide necessary information for long-term studies aimed at developing a better understanding of the cause-and-effect relationship between impacts and the ecosystem response. The RTI DCERP Team will continue to work with SERDP, the Naval Facilities Engineering Service Center, and the Base to develop a scientific framework for assessing the impacts of military training that can then be used by the researchers to guide experimental treatments for assessing and mitigating the effects of military training to ensure long-term sustainability of the military mission and ecosystem integrity at MCBCL.

10. Data and Information Management System

The purpose of the DCERP DIMS is to initially support the data management needs of DCERP and to ultimately support those of MCBCL's long-term ecosystem-based data management. The DIMS to be created will be a computerized system that enables broad data management functions necessary to support the complex information technology environment, various end users, research collaboration, and complex and voluminous environmental data to be collected and used to support DCERP.

To support the data management needs of DCERP and to support the complex and voluminous environmental data to be collected and used for DCERP, it is crucial to make research results, monitoring information, and other data accessible to the DCERP Team. The DIMS will be a database-driven Internet system that provides a means to access the DCERP data collections. To accomplish this, the DCERP DIMS will consist of the Monitoring and Research Data Information System (MARDIS), the Document Database, public and Collaborative Web sites, and a GIS Mapping Tool for MARDIS.

DCERP Data and Information Management System

- Monitoring and Research Data Information System (MARDIS)
- Document Database
- Collaborative Web site (password protected)
- Public Web site
- Geographic Information Systems Mapping Tool for MARDIS

The public and Collaborative Web sites were online in March 2007 and are periodically updated with MCBCL-approved information. The first versions of MARDIS and the Document Database are scheduled to be completed by September 2008. These tools will allow the RTI DCERP Team members to upload data into the DIMS and make it available to the entire DCERP Team. During the next year, the Web-mapping application will also become available, which will allow DCERP Module Team members to view spatial data and imagery available in MARDIS and to download or order spatial datasets.

11. Summary

The goal of the DCERP is to conduct Base-relevant and basic and applied research in support of an ecosystem-based management approach at MCBCL. The results of this research will provide a better understanding of the composition, structure, and function of estuarine and coastal ecosystems as they relate to MCBCL's military mission, as well as an understanding of what on-site and off-site Base activities affect these ecosystems and what management actions could be implemented to best sustain MCBCL military training and testing resources.